

Applicant: Wasserscheid et al.
Filing Date: March 11, 2004

Amendments to the Claims

Docket No. VSKW-1

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Claims

We claim the following:

- 1) (Canceled)
- 2) (Currently Amended) A ~~method of process for~~ using a compound of the Formula 1 in a
5 process,

(cation)(R'SO₄)

Formula 1

comprising the step of: employing the compound as a solvent, or solvent additive in a
10 chemical process, ~~or~~ ; employing the compound as an extraction solvent for a material
separation; or employing the compound as a heat carrier, or heat carrier additive in a heat
exchange unit, wherein:

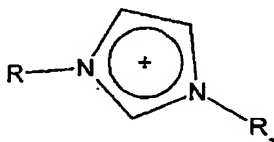
R' is selected from the group consisting of a linear or branched, saturated or unsaturated,
aliphatic or alicyclic, functionalized or non-functionalized alkyl radical with 3-36 carbon atoms,
wherein R' is optionally functionalized with one or more X groups; X is selected from the group
15 consisting of an -OH, -OR'', -COOH, -COOR'', -NH₂, -SO₄, -F, -Cl, -Br, -I or -CN; and R'' is
selected from the group consisting of a branched or linear hydrocarbon chain with 1 - 12 carbon
atoms;

the compound has a melting point of less than 100° C; and

the cation is a nitrogen-containing cation selected from the group consisting of a
20 quaternary ammonium cation, an imidazolium cation, a pyridinium cation, a pyrazolium cation, a
phosphonium and a triazolium cation.

- 3) (Previously Amended) The method of claim 2, wherein the cation is selected from the group
consisting of:

- a) quaternary ammonium cation with the general formula (NR₁R₂R₃R)⁺;
- 25 b) phosphonium cation with the general formula (PR₁R₂R₃R)⁺;
- c) imidazolium cation with the general formula



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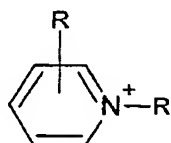
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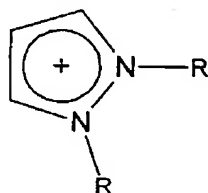
in which the imidazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group;

d) pyridinium cation with the general formula



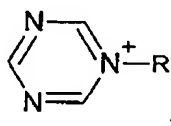
in which the pyridine core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group;

e) pyrazolium cation with the general formula



in which the pyrazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group; and

f) triazolium cation with the general formula



in which the triazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group; wherein

g) the radicals R¹, R², R³ are selected independently at each occurrence from the group consisting of:

i) hydrogen;

ii) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

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iii) heteroaryl groups, heteroaryl-C₁-C₆ alkyl groups with 3 to 8 carbon atoms in the heteroaryl radical and at least one heteroatom selected from N, O and S which is optionally substituted with at least one group selected from C₁-C₆ alkyl groups and/or halogen atoms;

5 iv) aryl, aryl-C₁-C₆ alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C₁-C₆ alkyl group and/or a halogen atom; and

h) the radical R is selected from the group consisting of:

i) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

10 ii) heteroaryl-C₁-C₆ alkyl groups with 3 to 8 carbon atoms in the aryl radical and at least one heteroatom selected from N, O and S, which is optionally substituted with at least one C₁-C₆ alkyl group and/or halogen atom; and

iii) aryl-C₁-C₆ alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C₁-C₆ alkyl group and/or halogen atom.

15 4) (Previously Amended) The method of claim 2, wherein the anion has an empirical formula selected from the group consisting of C₄H₉SO₄, C₈H₁₇SO₄ or C₁₂H₂₅SO₄.

5) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 has a melting point of less than 75° C.

20 6) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 has a melting point of less than 50° C.

7) (Previously Amended) The method of claim 2, wherein (R'SO₄) is an alkyl sulfate ester, wherein the alkyl moiety is selected from the group consisting of butyl, octyl, 2-ethylhexyl, and dodecyl; and the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.

25 8) (Previously Amended) The method of claim 7, wherein the cation is a nitrogen containing cation selected from the group consisting of 1-ethyl-3-methylimidazolium, 1-butyl-3-methylimidazolium butyl, 1-hexyl-3-methylimidazolium, 1-octyl-3-methylimidazolium, 1-decyl-3-methylimidazolium, 1-dodecyl-3-methylimidazolium, 1-butyl-pyridinium,
30 trimethyldecylammonium, trioctylmethylammonium, trimethyldecylammonium, and trihexyltetradecylphosphonium.

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- 9) (Previously Amended) The method of claim 2, wherein the cation is a nitrogen containing cation selected from the group consisting of 1-ethyl-3-methylimidazolium, 1-butyl-3-methylimidazolium butyl, 1-hexyl-3-methylimidazolium, 1-octyl-3-methylimidazolium, 1-decyl-3-methylimidazolium, 1-dodecyl-3-methylimidazolium, 1-butyl-pyridinium, trimethyldecylammonium, trioctylmethylammonium, trimethyldecylammonium, and trihexyltetradecylphosphonium; and the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.
- 10) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 is used in a reaction catalyzed by a transition metal; and the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.
- 11) (Previously Amended) The method of claim 10, wherein the compound of the Formula 1 is used in a hydroformylation reaction, oligomerization reaction, esterification reaction, isomerization reaction or amide bond-forming reaction.
- 12) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 is used in a reaction catalyzed by an enzyme or biocatalyst; and the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.
- 13) (Previously Amended) The method of claim 12, wherein the compound of the Formula 1 is used in an oligomerization reaction, C-C bond-forming reaction, esterification reaction, isomerization reaction, or amide bond-forming reaction.
- 14) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 is substantially hydrolytically stable in neutral aqueous solution (pH = 7) up to 80° C.
- 15) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 has a melting point of less than 25° C.
- 16) (Previously Amended) The method of claim 2, wherein the compound is selected from the group consisting of:

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- a) 1-ethyl-3-methylimidazolium butyl sulfate;
- b) 1-ethyl-3-methylimidazolium octyl sulfate;
- c) 1-ethyl-3-methylimidazolium 2-ethylhexyl sulfate;
- d) 1-ethyl-3-methylimidazolium dodecyl sulfate;
- 5 e) 1-butyl-3-methylimidazolium butyl sulfate;
- f) 1-butyl-3-methylimidazolium octyl sulfate;
- g) 1-butyl-3-methylimidazolium 2-ethylhexyl sulfate;
- h) 1-butyl-3-methylimidazolium dodecyl sulfate;
- i) 1-hexyl-3-methylimidazolium butyl sulfate;
- 10 j) 1-hexyl-3-methylimidazolium octyl sulfate;
- k) 1-hexyl-3-methylimidazolium 2-ethylhexyl sulfate;
- l) 1-hexyl-3-methylimidazolium dodecyl sulfate;
- m) 1-octyl-3-methylimidazolium butyl sulfate;
- n) 1-octyl-3-methylimidazolium octyl sulfate;
- 15 o) 1-octyl-3-methylimidazolium 2-ethylhexyl sulfate;
- p) 1-octyl-3-methylimidazolium dodecyl sulfate;
- q) 1-decyl-3-methylimidazolium butyl sulfate;
- r) 1-decyl-3-methylimidazolium octyl sulfate;
- s) 1-decyl-3-methylimidazolium 2-ethylhexyl sulfate;
- 20 t) 1-decyl-3-methylimidazolium dodecyl sulfate;
- u) 1-dodecyl-3-methylimidazolium butyl sulfate;
- v) 1-dodecyl-3-methylimidazolium octyl sulfate;
- w) 1-dodecyl-3-methylimidazolium 2-ethylhexyl sulfate;
- x) 1-dodecyl-3-methylimidazolium dodecyl sulfate;
- 25 y) 1-butyl-pyridinium butyl sulfate;
- z) 1-butyl-pyridinium octyl sulfate;
- aa) 1-butyl-pyridinium 2-ethylhexyl sulfate;
- bb) 1-butyl-pyridinium dodecyl sulfate;
- cc) trimethyldecylammonium butyl sulfate;
- 30 dd) trimethyldecylammonium 2-ethylhexyl sulfate;
- ee) trioctylmethylammonium butyl sulfate;

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ff) trioctylmethylammonium octyl sulfate;

gg) trioctylmethylammonium 2-ethylhexyl sulfate;

hh) trioctylmethylammonium dodecyl sulfate;

ii) trimethyldecylammonium butyl sulfate;

5 jj) trimethyldecylammonium octyl sulfate;

kk) trihexyltetradecylphosphonium butyl sulfate;

ll) trihexyltetradecylphosphonium octyl sulfate;

mm) trihexyltetradecylphosphonium 2-ethylhexyl sulfate;

nn) trihexyltetradecylphosphonium dodecyl sulfate; and the method comprises the step of:

10 employing the compound as a solvent, solvent additive, or extraction solvent; or
employing the compound as a heat carrier, or heat carrier additive; or employing the
compound as a phase transfer catalyst.

17) (Currently Amended) A method of using a compound of the Formula 1 in a process

(cation)(R'SO₄)

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Formula 1

comprising the step of: employing the compound as a solvent, or solvent additive in a
chemical process, ~~or~~ ; employing the compound as an extraction solvent for a material
separation; or employing the compound as a heat carrier, or heat carrier additive in a heat
exchange unit, wherein:

20 R' is selected from the group consisting of a linear or branched, saturated or unsaturated,
aliphatic or alicyclic, functionalized or non-functionalized alkyl radical with 3-36 carbon atoms,
wherein R' is optionally functionalized with one or more X groups; X is selected from the group
consisting of an -OH, -OR'', -COOH, -COOR'', -NH₂, -SO₄, -F, -Cl, -Br, -I or -CN; and R'' is
25 selected from the group consisting of a branched or linear hydrocarbon chain with 1 - 12 carbon
atoms;

the compound has a melting point of less than 100° C;

the cation is a nitrogen-containing cation selected from the group consisting of a
quaternary ammonium cation, an imidazolium cation, a pyridinium cation, a pyrazolium cation, a
phosphonium and a triazolium cation;

30 the compound of the Formula 1 is substantially hydrolytically stable in neutral aqueous
solution (pH = 7) up to 80° C.

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18) (Previously Amended) The method of claim 17, wherein (R'SO₄) has an empirical formula selected from the group consisting of C₄H₉SO₄, C₈H₁₇SO₄ or C₁₂H₂₅SO₄, and; the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.

19) (Currently Amended) A method of using a compound of the Formula 1 in a process

(cation)(R'SO₄)

Formula 1

comprising the step of: employing the compound as a solvent, or solvent additive in a chemical process, ~~or~~ ; employing the compound as an extraction solvent for a material separation; or employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit, wherein:

- a) (R'SO₄) is an alkyl sulfate ester, wherein the alkyl moiety is selected from the group consisting of butyl, octyl, 2-ethylhexyl, and dodecyl;
- b) the cation is a nitrogen containing cation selected from the group consisting of 1-ethyl-3-methylimidazolium, 1-butyl-3-methylimidazolium butyl, 1-hexyl-3-methylimidazolium, 1-octyl-3-methylimidazolium, 1-decyl-3-methylimidazolium, 1-dodecyl-3-methylimidazolium, 1-butyl-pyridinium, trimethyldecylammonium, trioctylmethylammonium, trimethyldecylammonium, and trihexyltetradecylphosphonium;
- c) the compound has a melting point of less than 100° C; and
- d) the compound of the Formula 1 is substantially hydrolytically stable in neutral aqueous solution (pH = 7) up to 80° C.

20) (Previously Amended) The method of claim 19, wherein the process is a reaction catalyzed by a transition metal, and the reaction is a hydroformylation reaction, oligomerization reaction, esterification reaction, isomerization reaction or amide bond-forming reaction.

21) (Previously Amended) The method of claim 19, wherein the process is a reaction catalyzed by an enzyme or biocatalyst, and the reaction is an oligomerization reaction, C-C bond-forming reaction, esterification reaction, isomerization reaction, or amide bond-forming reaction.

22) (Previously added) The method of claim 18, wherein the cation is selected from the group

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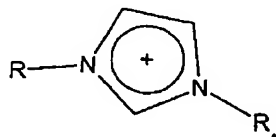
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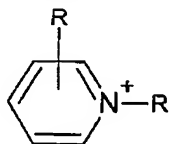
consisting of:

- a) quaternary ammonium cation with the general formula $(NR_1R_2R_3R)^+$;
- b) phosphonium cation with the general formula $(PR_1R_2R_3R)^+$;
- c) imidazolium cation with the general formula



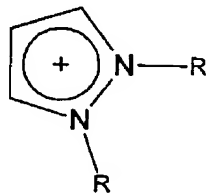
in which the imidazole core is optionally substituted with at least one group selected from C_1 - C_6 alkyl group, C_1 - C_6 alkoxy group, C_1 - C_6 aminoalkyl group, C_5 - C_{12} aryl group or C_5 - C_{12} -aryl- C_1 - C_6 alkyl group;

- d) pyridinium cation with the general formula



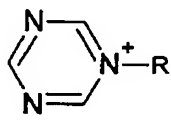
in which the pyridine core is optionally substituted with at least one group selected from C_1 - C_6 alkyl group, C_1 - C_6 alkoxy group, C_1 - C_6 aminoalkyl group, C_5 - C_{12} aryl group or C_5 - C_{12} -aryl- C_1 - C_6 alkyl group;

- e) pyrazolium cation with the general formula



in which the pyrazole core is optionally substituted with at least one group selected from C_1 - C_6 alkyl group, C_1 - C_6 alkoxy group, C_1 - C_6 aminoalkyl group, C_5 - C_{12} aryl group or C_5 - C_{12} -aryl- C_1 - C_6 alkyl group; and

- f) triazolium cation with the general formula



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in which the triazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group; wherein

g) the radicals R¹, R², R³ are selected independently at each occurrence from the group consisting of:

i) hydrogen;

ii) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

iii) heteroaryl groups, heteroaryl-C₁-C₆ alkyl groups with 3 to 8 carbon atoms in the heteroaryl radical and at least one heteroatom selected from N, O and S which is optionally substituted with at least one group selected from C₁-C₆ alkyl groups and/or halogen atoms;

iv) aryl, aryl-C₁-C₆ alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C₁-C₆ alkyl group and/or a halogen atom; and

h) the radical R is selected from the group consisting of:

i) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

ii) heteroaryl-C₁-C₆ alkyl groups with 3 to 8 carbon atoms in the aryl radical and at least one heteroatom selected from N, O and S, which is optionally substituted with at least one C₁-C₆ alkyl group and/or halogen atom; and

iii) aryl-C₁-C₆ alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C₁-C₆ alkyl group and/or halogen atom.